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APPLICATION

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TITLE: MULTIPLEXING AND DEMULTIPLEXING OPTICAL SIGNALS

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MULTIPLEXING AND DEMULTIPLEXING OPTICAL SIGNALS

Background

This invention relates generally to optoelectrical systems.

Optoelectrical systems transmit signals both by optical and electrical means. Transducers are utilized to convert optical to electrical signals and vice versa.

Commonly, light information must be converted into electrical information. In many cases, the light information may be multiplexed so that a number of different wavelengths are transmitted over the same optical fiber. For example, in wavelength division multiplexing, a large number of signals may be transmitted over the same fiber.

Thus, there is a need for ways to demultiplex the signals and/or add additional signals to the optical stream.

Brief Description of the Drawings

Figure 1 is a top plan view of one embodiment of the present invention;

Figure 2 is a partial, cross-sectional view of a portion of the embodiment shown in Figure 1 in accordance with one embodiment of the present invention; and

Figure 3 is an enlarged, cross-sectional view of a portion of the embodiment shown in Figure 1 in accordance with one embodiment of the present invention.

Detailed Description

Referring to Figure 1, an optical connector 12 may connect to an optical cable or fiber. A fiber 14 conveys a signal from the connector 12 to a silicon electrooptical bench 16. The fiber 14 may be coupled to the bench 16 through a fiber mount 18 mounted on the bench 16 so that the fiber 14 is fixed between the mount 18 and a V-shaped groove 19 formed in the upper surface of the bench 16. A fiber-waveguide interface 20 converts the signal from the fiber 14 to an appropriate form to be transmitted over a waveguide 22 formed within the bench 16.

Thus, in one embodiment, at least two wavelengths, indicated as wavelengths A and B, may be transmitted from the cable through the fiber 14 to the waveguide 22. A signal from the cable may be wavelength division multiplexed in one embodiment of the present invention. That signal passes through a coupler 34 to a filter 24. The filter 24 may pass one wavelength, such as the wavelength B. The wavelength B may then be detected by the detector 26 and connected to an electrical signal.

Another wavelength, such as the wavelength A, is not passed by the filter 24 but, instead, is reflected by it, over the path 38, to be detected by a wavelength A detector

30. The detected optical signal may be converted into an electrical signal by the detector 30.

At the same time, a laser 32 generates a signal of wavelength C which is partially transmitted over the curved waveguide 40 through the coupler 34 to a power monitor 36 for monitoring the power of the signal of wavelength C. The remainder of the wavelength C signal may be impressed onto the waveguide 22 across the coupler 34. The signal of wavelength C may be provided by the bench 16 back through the fiber 14 and the coupler 12 to the cable. As a result, two wavelengths may be removed and detected and a third wavelength may be added back to the multiplexed communication system. Of course, any number of signals may be added or removed in other embodiments. In one embodiment, the wavelengths A and B are wavelength division multiplexed wavelengths such as 1490 and 1550 nm, and the wavelength C is in a separate wavelength band such as 1310 nm.

Referring to Figure 2, the laser 32 may be arranged to be fit within a trench defined within the surface of the bench 16. The laser 32 is connected to the lead 54 by thermocompression or other bonding techniques. The laser 32 is aligned with the laser waveguide 34 adjusted to the waveguide 40 embedded in the silicon electro-optical bench 16.

The filter 24 and detector element 44 may be implemented as an integrated unit to form the detector 26 as indicated in Figure 3. The filter 24 may be formed by a film that is secured to the photodetector element 44. The detector 26 may include an L-shaped package, including a relatively vertical portion 46 and a relatively horizontal portion 48 that may be secured to the bench 16 by an adhesive 50 in one embodiment. The detector element 44 may be secured and electrically interconnected to the L-shaped package portions 46 and 48 by thermocompression bonding in one embodiment, or by solder in another embodiment. Alternatively, wire bonding may also be utilized for the electrical connection, with adhesive for the mechanical connection. In one embodiment, the portions 46 and 48 may be multilayer packages electrically connected at 90 degrees to form an L-shaped mount. The L-shaped package may be made of two multilayer packages connected at ninety degrees by brazing or soldering. The second multilayer package provides easy access for the electrical connections to the silicon electrooptical bench 16. As another embodiment, the L-shaped mount may be formed of a lead frame instead of a second multilayer package that may be soldered down onto the silicon optical bench at ninety degrees.

Electrical signals may be coupled to and from the detector 26 as indicated by the wire bond 52.

In one embodiment, the filter 24 may be formed of a conventional, commercially available, thin film filter component. Such thin film filters may have alternate layers of appropriate thin films like Al_2O_3, TiO_2, SiO_2, etc., which may be deposited on an appropriate substrate, such as a glass substrate. The filter 24 may be adhesively secured on the photodetector element 44 by way of an optical adhesive in one embodiment.

In some embodiments, the integrated structure may be advantageous since a separate pick and place operation for placing the thin film filter and for placing the detector 26 may be avoided.

A second approach may be to directly deposit alternate layers of appropriate thin films on the photodetector element 44. Of course, this deposition may be done while the photodetector element 44 is still in the wafer format. This approach may be advantageous, in some embodiments, as it may decrease optical losses by eliminating the thickness of the glass substrate that is found in commercial thin film filters.

The detector 26 detects the wavelength that is transmitted through the thin film filter 24. The reflected wavelength is coupled to the path 38 in the silicon electrooptical bench 16. As the optical angle of incidence at the detector 26 may be important to make sure the losses are reduced, a precision trench sidewall 58 may be used for

reference during assembly in some embodiments. After the filter detector hybrid is picked and placed, it is slid to the sidewall of the trench 58 to couple to the waveguide 72. The base of the trench 58 serves as the bottom reference plane for alignment and provides stability during the pick and place operations. To provide mechanical robustness, the gap between the filter detector hybrid may be filled using optical epoxy on the waveguide side, and on the non-active side as well, as needed.

The L-mount arrangement may facilitate electrical connections from the detector 26 that are in the vertical plane and may transfer them to the horizontal plane on top of the silicon optical bench 16, essentially providing a ninety degree bend for electrical connections. On the horizontal plane, electrical connections to the silicon optical bench may be made using wire bonding or solder bonding.

While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

What is claimed is: